

November 1994

## 54F/74F138 1-of-8 Decoder/Demultiplexer

### General Description

The 'F138 is a high-speed 1-of-8 decoder/demultiplexer. This device is ideally suited for high-speed bipolar memory chip select address decoding. The multiple input enables allow parallel expansion to a 1-of-24 decoder using just three 'F138 devices or a 1-of-32 decoder using four 'F138 devices and one inverter.

### Features

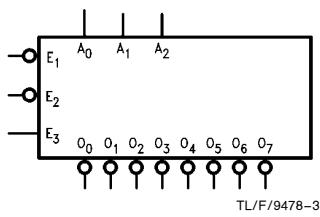
- Demultiplexing capability
- Multiple input enable for easy expansion
- Active LOW mutually exclusive outputs
- Guaranteed 4000V minimum ESD protection

Commercial	Military	Package Number	Package Description
74F138PC		N16E	16-Lead (0.300" Wide) Molded Dual-In-Line
	54F138DM (Note 2)	J16A	16-Lead Ceramic Dual-In-Line
74F138SC (Note 1)		M16A	16-Lead (0.150" Wide) Molded Small Outline, JEDEC
74F138SJ (Note 1)		M16D	16-Lead (0.300" Wide) Molded Small Outline, EIAJ
	54F138FM (Note 2)	W16A	16-Lead Cerpack
	54F138LM (Note 2)	E20A	20-Lead Ceramic Leadless Chip Carrier, Type C

Note 1: Devices also available in 13" reel. Use suffix = SCX and SJX.

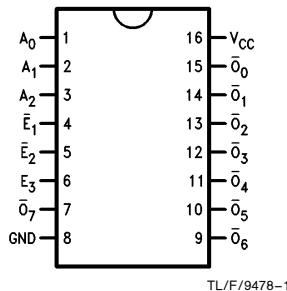
Note 2: Military grade device with environmental and burn-in processing. Use suffix = DMQB, FMQB and LMQB.

### Logic Symbols

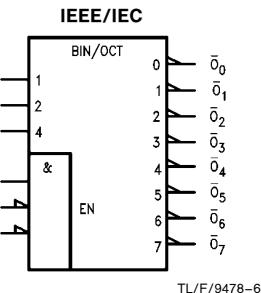
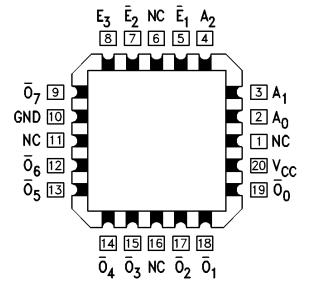


### Connection Diagrams

Pin Assignment for DIP,  
SOIC and Flatpak



Pin Assignment  
for LCC



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## Unit Loading/Fan Out

Pin Names	Description	54F/74F	
		U.L. HIGH/LOW	Input $I_{IH}/I_{IL}$ Output $I_{OH}/I_{OL}$
$A_0-A_2$ $\bar{E}_1, \bar{E}_2$ $E_3$ $\bar{O}_0-\bar{O}_7$	Address Inputs Enable Inputs (Active LOW) Enable Input (Active HIGH) Outputs (Active LOW)	1.0/1.0 1.0/1.0 1.0/1.0 50/33.3	20 $\mu$ A/-0.6 mA 20 $\mu$ A/-0.6 mA 20 $\mu$ A/-0.6 mA -1 mA/20 mA

## Functional Description

The 'F138 high-speed 1-of-8 decoder/demultiplexer accepts three binary weighted inputs ( $A_0, A_1, A_2$ ) and, when enabled, provides eight mutually exclusive active LOW outputs ( $\bar{O}_0-\bar{O}_7$ ). The 'F138 features three Enable inputs, two active LOW ( $\bar{E}_1, \bar{E}_2$ ) and one active HIGH ( $E_3$ ). All outputs will be HIGH unless  $\bar{E}_1$  and  $\bar{E}_2$  are LOW and  $E_3$  is HIGH. This multiple enable function allows easy parallel expansion

of the device to a 1-of-32 (5 lines to 32 lines) decoder with just four 'F138 devices and one inverter (See *Figure 1*). The 'F138 can be used as an 8-output demultiplexer by using one of the active LOW Enable inputs as the data input and the other Enable inputs as strobes. The Enable inputs which are not used must be permanently tied to their appropriate active HIGH or active LOW state.

## Truth Table

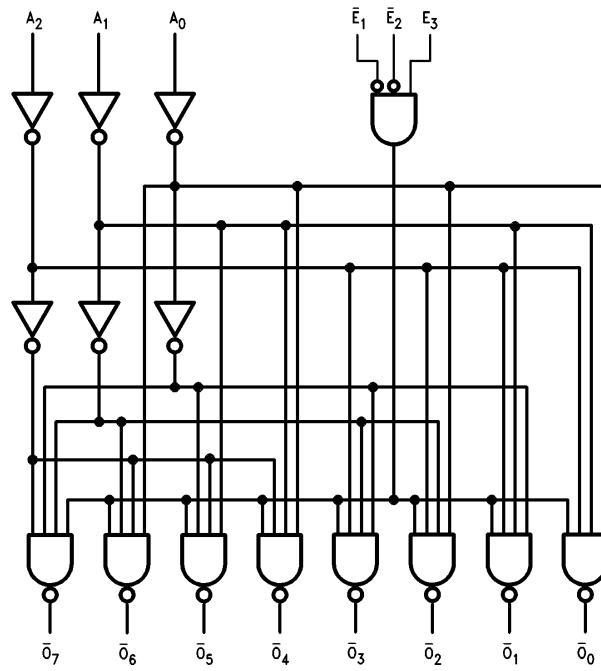
Inputs					Outputs								
$\bar{E}_1$	$\bar{E}_2$	$E_3$	$A_0$	$A_1$	$A_2$	$\bar{O}_0$	$\bar{O}_1$	$\bar{O}_2$	$\bar{O}_3$	$\bar{O}_4$	$\bar{O}_5$	$\bar{O}_6$	$\bar{O}_7$
H	X	X	X	X	X	H	H	H	H	H	H	H	H
X	H	X	X	X	X	H	H	H	H	H	H	H	H
X	X	L	X	X	X	H	H	H	H	H	H	H	H
L	L	H	L	L	L	L	H	H	H	H	H	H	H
L	L	H	H	L	L	H	L	H	H	H	H	H	H
L	L	H	L	H	L	H	H	L	H	H	H	H	H
L	L	H	H	H	L	H	H	H	L	H	H	H	H
L	L	H	L	L	H	H	H	H	H	L	H	H	H
L	L	H	H	L	H	H	H	H	H	H	L	H	H
L	L	H	L	H	H	H	H	H	H	H	H	L	H
L	L	H	H	H	H	H	H	H	H	H	H	H	L

H = HIGH Voltage Level

L = LOW Voltage Level

X = Immortal

## Logic Diagram



TL/F/9478-4

Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Storage Temperature	−65°C to +150°C
Ambient Temperature under Bias	−55°C to +125°C
Junction Temperature under Bias Plastic	−55°C to +175°C −55°C to +150°C
V <sub>CC</sub> Pin Potential to Ground Pin	−0.5V to +7.0V
Input Voltage (Note 2)	−0.5V to +7.0V
Input Current (Note 2)	−30 mA to +5.0 mA
Voltage Applied to Output in HIGH State (with V <sub>CC</sub> = 0V)	−0.5V to V <sub>CC</sub>
Standard Output	−0.5V to +5.5V
TRI-STATE® Output	−0.5V to +5.5V
Current Applied to Output in LOW State (Max)	twice the rated I <sub>OL</sub> (mA)
ESD Last Passing Voltage (Min)	4000V

**Note 1:** Absolute maximum ratings are values beyond which the device may be damaged or have its useful life impaired. Functional operation under these conditions is not implied.

**Note 2:** Either voltage limit or current limit is sufficient to protect inputs.

## Recommended Operating Conditions

Free Air Ambient Temperature	−55°C to +125°C
Military	0°C to +70°C
Commercial	
Supply Voltage	+4.5V to +5.5V
Military	+4.5V to +5.5V
Commercial	

## DC Electrical Characteristics

Symbol	Parameter	54F/74F			Units	V <sub>CC</sub>	Conditions
		Min	Typ	Max			
V <sub>IH</sub>	Input HIGH Voltage	2.0			V		Recognized as a HIGH Signal
V <sub>IL</sub>	Input LOW Voltage		0.8		V		Recognized as a LOW Signal
V <sub>CD</sub>	Input Clamp Diode Voltage		−1.2		V	Min	I <sub>IN</sub> = −18 mA
V <sub>OH</sub>	Output HIGH Voltage 54F 10% V <sub>CC</sub> 74F 10% V <sub>CC</sub> 74F 5% V <sub>CC</sub>	2.5 2.5 2.7			V	Min	I <sub>OH</sub> = −1 mA I <sub>OH</sub> = −1 mA I <sub>OH</sub> = −1 mA
V <sub>OL</sub>	Output LOW Voltage 54F 10% V <sub>CC</sub> 74F 10% V <sub>CC</sub>		0.5 0.5		V	Min	I <sub>OL</sub> = 20 mA I <sub>OL</sub> = 20 mA
I <sub>IH</sub>	Input HIGH Current 54F 74F		20.0 5.0		μA	Max	V <sub>IN</sub> = 2.7V
I <sub>BVI</sub>	Input HIGH Current Breakdown Test 54F 74F		100 7.0		μA	Max	V <sub>IN</sub> = 7.0V
I <sub>CEX</sub>	Output HIGH Leakage Current 54F 74F		250 50		μA	Max	V <sub>OUT</sub> = V <sub>CC</sub>
V <sub>ID</sub>	Input Leakage Test 74F	4.75			V	0.0	I <sub>ID</sub> = 1.9 μA All Other Pins Grounded
I <sub>OD</sub>	Output Leakage Circuit Current 74F		3.75		μA	0.0	V <sub>OD</sub> = 150 mV All Other Pins Grounded
I <sub>IL</sub>	Input LOW Current		−0.6		mA	Max	V <sub>IN</sub> = 0.5V
I <sub>OS</sub>	Output Short-Circuit Current	−60	−150		mA	Max	V <sub>OUT</sub> = 0V
I <sub>CCH</sub>	Power Supply Current		13	20	mA	Max	V <sub>O</sub> = HIGH
I <sub>CCL</sub>	Power Supply Current		13	20	mA	Max	V <sub>O</sub> = LOW

## AC Electrical Characteristics

Symbol	Parameter	74F			54F		74F		Units	Fig. No.		
		$T_A = +25^\circ\text{C}$ $V_{CC} = +5.0\text{V}$ $C_L = 50\text{ pF}$			$T_A, V_{CC} = \text{Mil}$ $C_L = 50\text{ pF}$		$T_A, V_{CC} = \text{Com}$ $C_L = 50\text{ pF}$					
		Min	Typ	Max	Min	Max	Min	Max				
$t_{PLH}$	Propagation Delay $A_n$ to $\bar{O}_n$	3.5	5.6	7.5	3.0	12.0	3.5	8.5	ns	♦-3		
$t_{PHL}$	Propagation Delay $\bar{E}_1$ or $\bar{E}_2$ to $\bar{O}_n$	4.0	6.1	8.0	4.0	9.5	4.0	9.0	ns	♦-4		
$t_{PLH}$	Propagation Delay $E_3$ to $\bar{O}_n$	3.0	5.3	7.0	3.0	11.0	3.5	8.0	ns	♦-4		
$t_{PHL}$	Propagation Delay $E_3$ to $\bar{O}_n$	4.0	6.2	8.0	3.5	12.5	4.0	9.0	ns	♦-4		
		3.5	5.6	7.5	3.5	8.5	3.5	8.5				

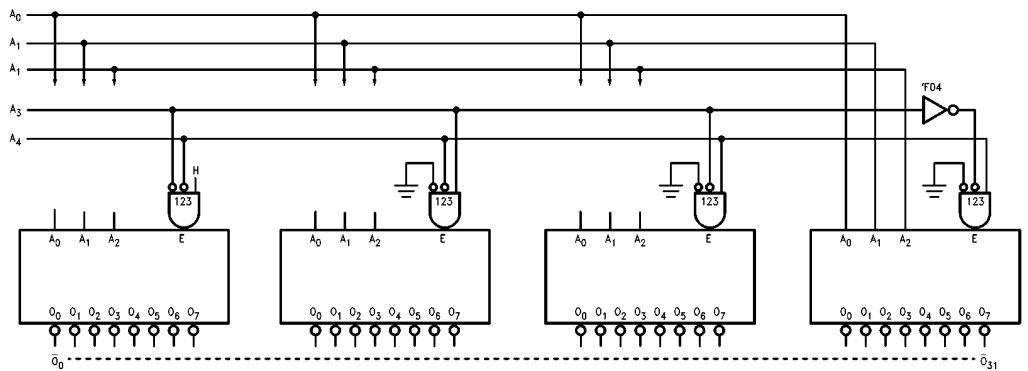
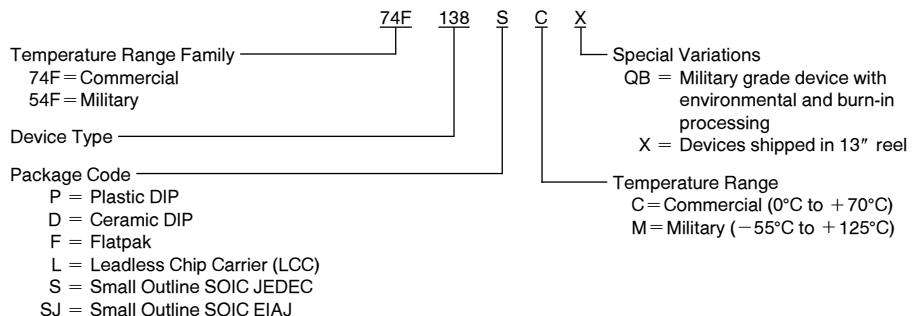


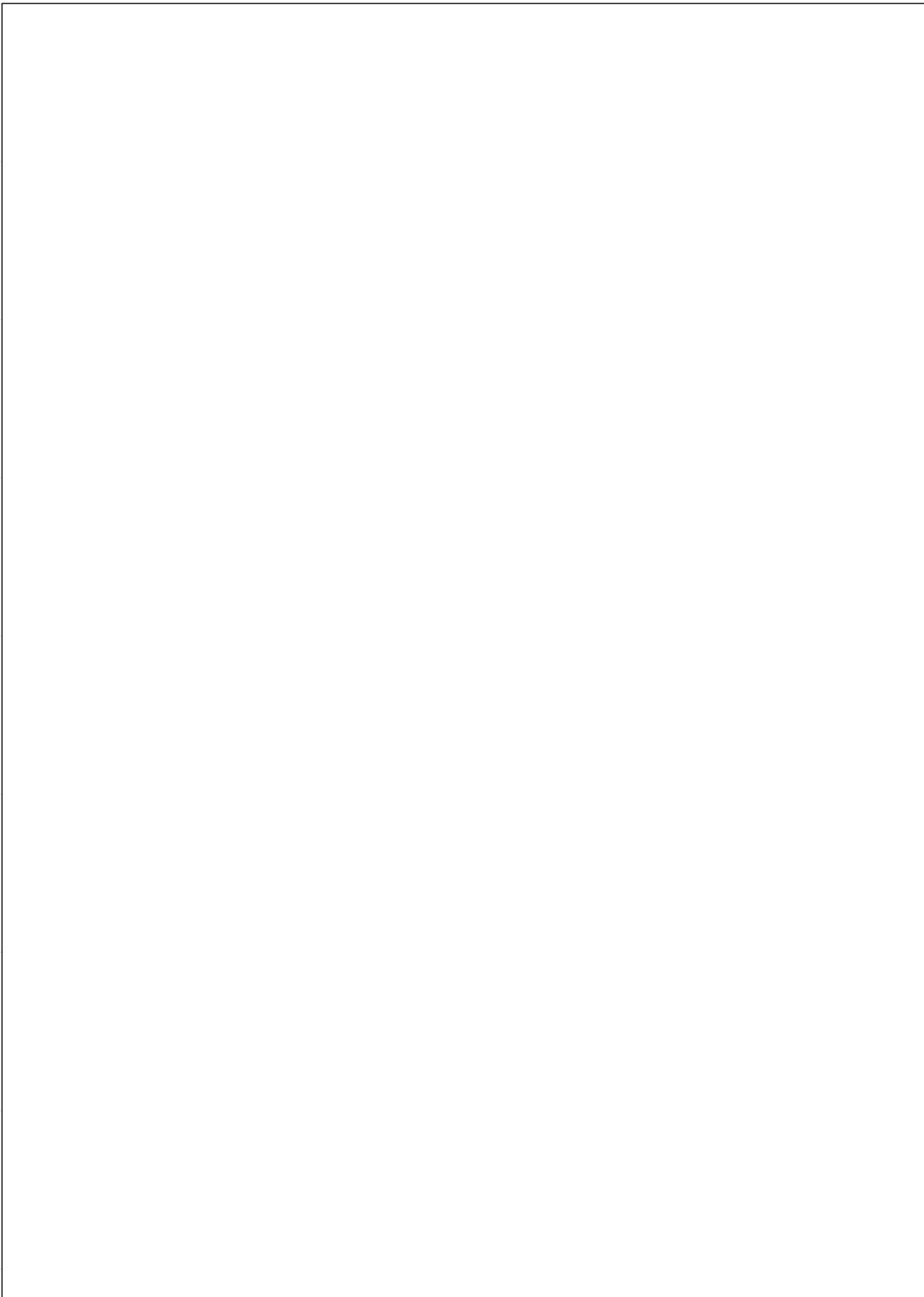
FIGURE 1. Expansion to 1-of-32 Decoding

TL/F/9478-5

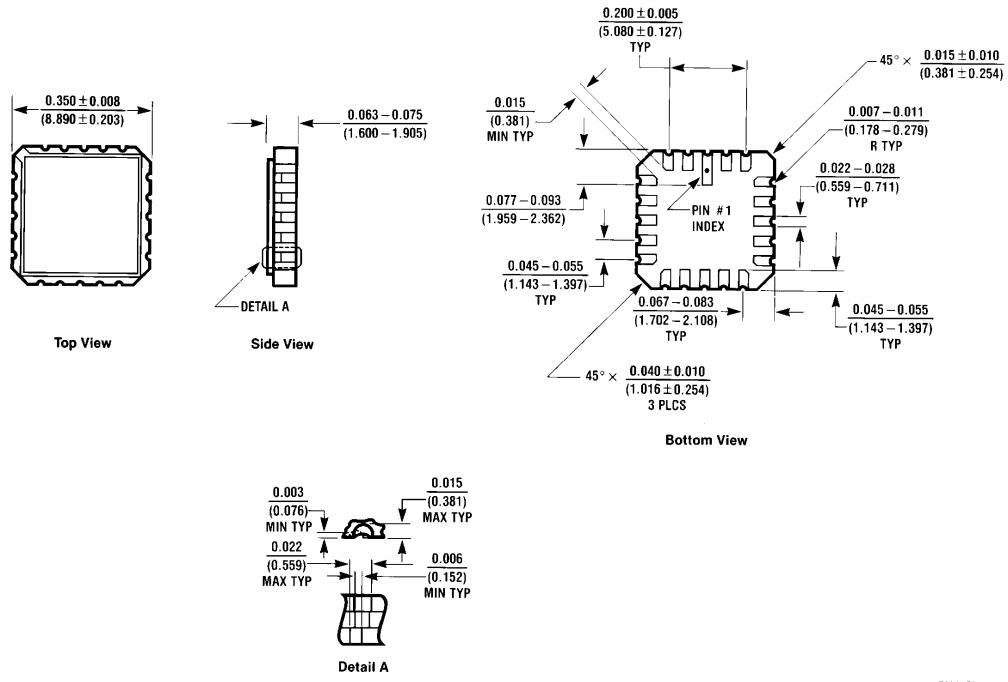
## Ordering Information

The device number is used to form part of a simplified purchasing code where the package type and temperature range are defined as follows:





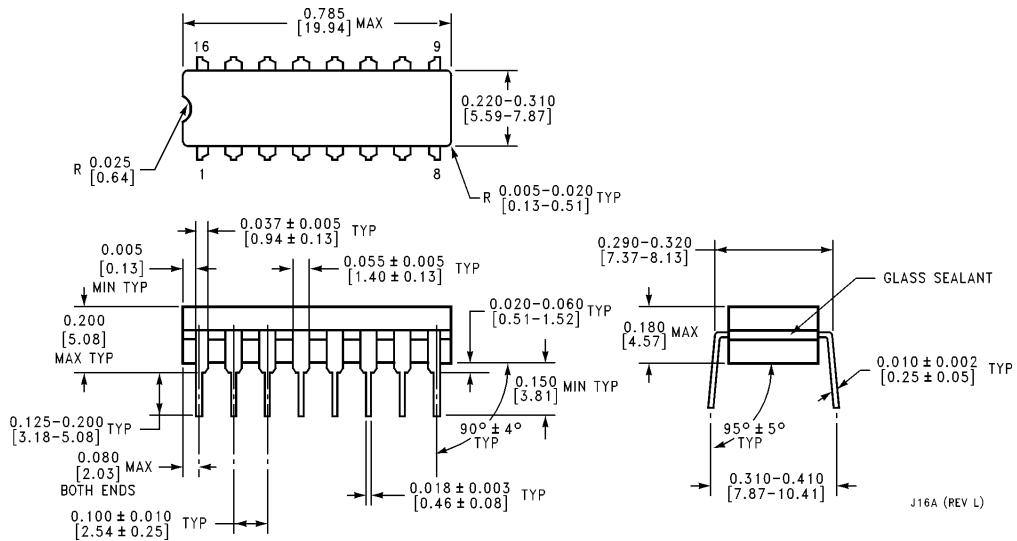
## Physical Dimensions inches (millimeters)



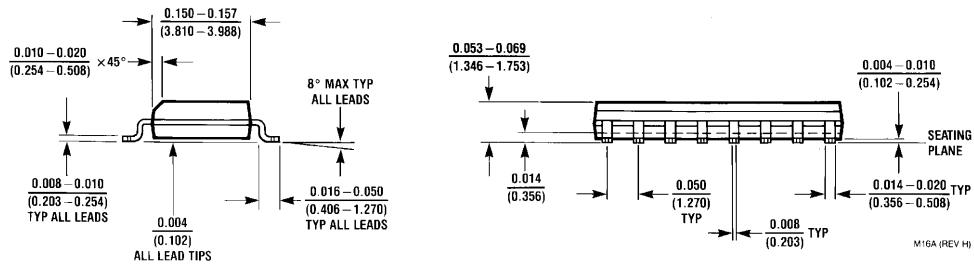
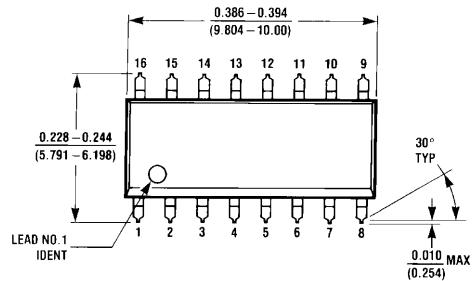
**20-Lead Ceramic Leadless Chip Carrier (L)  
NS Package Number E20A**

E20A (REV D)

## Physical Dimensions inches (millimeters) (Continued)

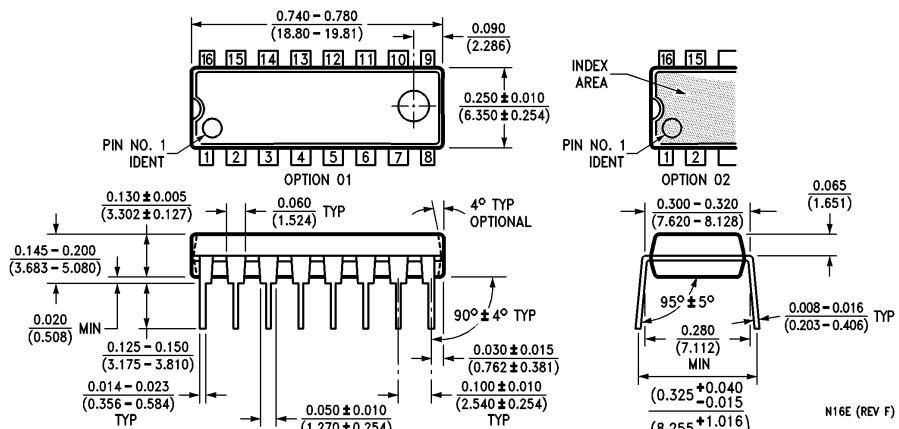
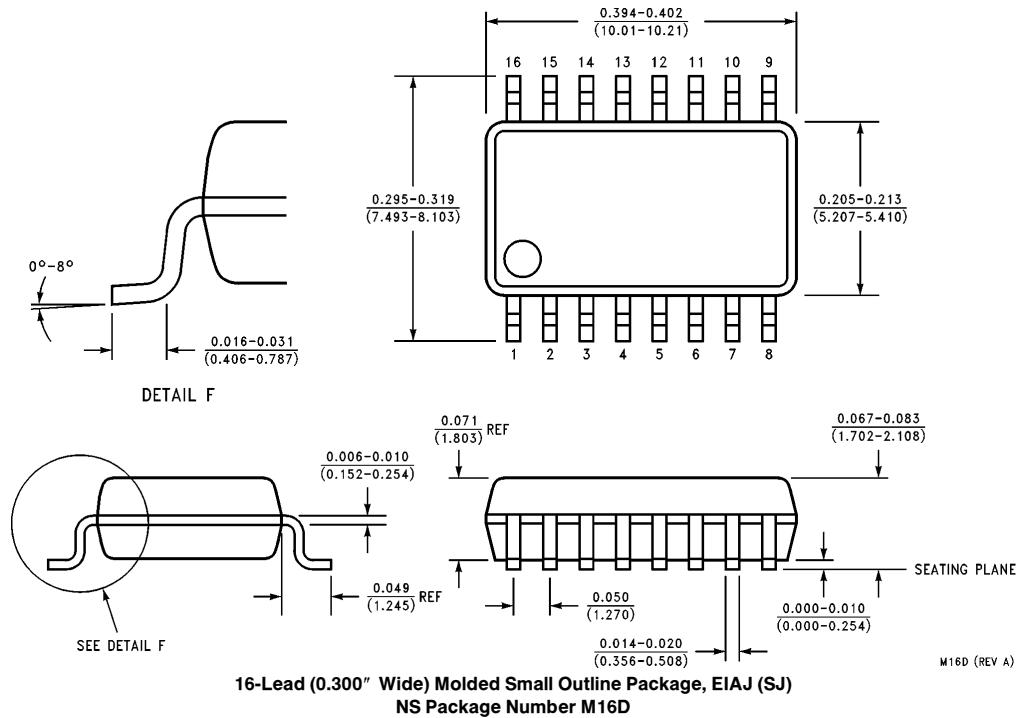


16-Lead Ceramic Dual-In-Line Package (D)  
NS Package Number J16A

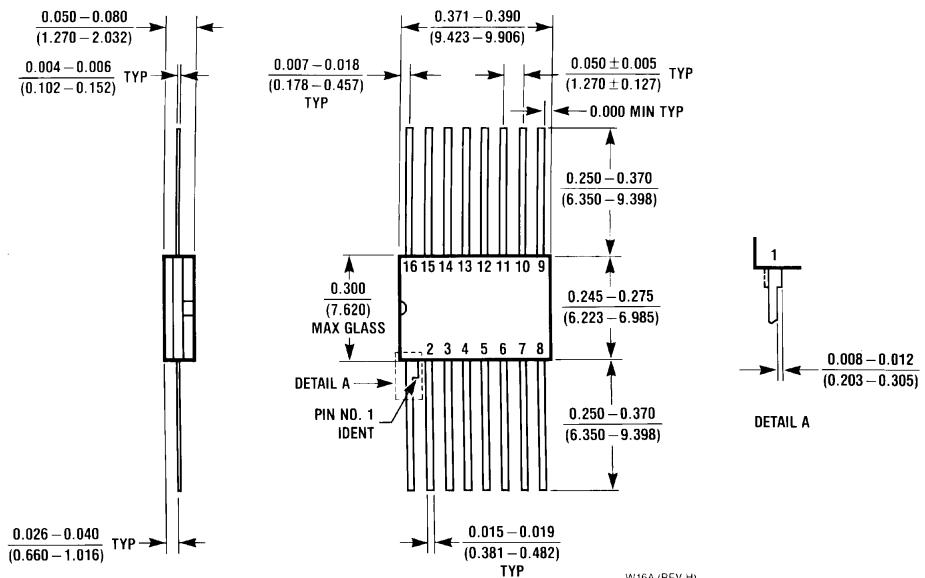


16-Lead (0.150" Wide) Molded Small Outline Package, JEDEC (S)  
NS Package Number M16A

## **Physical Dimensions** inches (millimeters) (Continued)



## **Physical Dimensions** inches (millimeters) (Continued)



**16-Lead Ceramic Flatpak (F)  
NS Package Number W16A**

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